METHODS OF OPERATING APPLICATION PROCESSORS AND DISPLAY SYSTEMS

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims priority under 35 U.S.C. §119 to Korean Patent Application No. 10-2015-0144743, filed on Oct. 16, 2015, in the Korean Intellectual Property Office, the disclosure of which is incorporated herein in its entirety by reference.

BACKGROUND

[0002] Field

[0003] Example embodiments relate to semiconductor devices, and more particularly, to methods of operating application processors to display images on display panels, and display systems including the same.

[0004] Description of Related Art

[0005] Electronic devices having an image display function (e.g., computers, tablet personal computers (PCs), smart phones, and wearable electronic devices) include a display system. The display system includes a display panel, a display driver (or a display driver integrated circuit (DDI)), and a processor. The display panel includes a plurality of pixels and may be embodied as a flat panel display, such as a liquid crystal display (LCD) or an organic light emitting diode (OLED), or a flexible display. As electronic devices to which the display system is applicable have been diversified, screens of display panels also have been diversified in shape, and thus, images are being displayed on screens having various shapes.

SUMMARY

[0006] At least some example embodiments provide methods of operating application processors capable of more efficiently driving display panels having screens of various shapes in terms of power consumption and/or performance. At least some example embodiments provide display systems including application processors.

[0007] According to at least one example embodiment, a method of operating an application processor configured to control a display device including a non-rectangular valid display region includes: receiving screen information regarding the non-rectangular valid display region; and outputting a plurality of pieces of valid pixel data to the display device, the plurality of pieces of valid pixel data selected based on the screen information, and the plurality of pieces of valid pixel data corresponding to the valid display region.

[0008] According to at least one other example embodiment, a display system includes: a display panel configured to display an image in a valid display region; an application processor; and a display driver. The application processor is configured to: receive screen information associated with the valid display region; and, based on the screen information, pack a plurality of pieces of valid pixel data, and output the plurality of pieces of packed valid pixel data. The plurality of pieces of valid pixel data corresponds to valid image data to be displayed in the valid display region. The display driver integrated circuit (IC) is configured to: restore the valid image data by unpacking the plurality of pieces of valid pixel data received from the application processor; and drive the display panel based on the valid image data.

[0009] At least one other example embodiment provides a method of operating an application processor to control a display device including a valid display region having a non-rectangular shape, the method comprising: receiving screen information associated with the valid display region; and outputting a plurality of pieces of valid pixel data, the plurality of pieces of valid pixel data selected based on the screen information and corresponding to the valid display region of the display device.

[0010] According to at least some example embodiments; the screen information may include a starting position of the valid display region and a number of pixels arranged continuously from the starting position in each of a plurality of lines of a display panel of the display device. The plurality of lines may be horizontal or vertical lines.

[0011] The valid display region may include at least two lines. Each of the at least two lines may include a different number of valid pixels, and the at least two lines may be horizontal or vertical lines.

[0012] The outputting a plurality of pieces of valid pixel data may include: packing the plurality of pieces of valid pixel data; writing the packed plurality of pieces of valid pixel data to a memory; and outputting the packed plurality of pieces of valid pixel data from the memory to the display device.

[0013] The writing the packed plurality of pieces of valid pixel data to a memory may include: writing, from among the packed plurality of pieces of valid pixel data; valid pixel data corresponding to at least two lines of the valid display region to at least one row or column of the memory, the at least two lines being horizontal or vertical lines of the valid display region.

[0014] The packing the plurality of pieces of valid pixel data may include: arranging the plurality of pieces of valid pixel data into units, each of the units including pixel data corresponding to a plurality of pixels.

[0015] The writing may write a first number of the packed plurality of pieces of valid pixel data to the memory; and the outputting may output the first number of the packed plurality of pieces of valid pixel data to the display device.

[0016] The outputting a plurality of pieces of valid pixel data may include: generating rectangular image data; storing the rectangular image data in a memory; selectively reading, based on the screen information, the plurality of pieces of valid pixel data from among the rectangular image data stored in the memory, the plurality of pieces of valid pixel data corresponding to the valid display region; and outputting the selectively read plurality of pieces of valid pixel data to the display device.

[0017] The method may further include: identifying valid pixel data corresponding to a portion of the valid display region to be updated; and outputting the identified valid pixel data and location information of the portion of the valid display region to the display device.

[0018] At least one other example embodiment provides a display system comprising: a display panel configured to display an image in a valid display region; an application processor; and a display driver circuit. The application processor is configured to execute computer readable instructions such that the application processor is configured to: receive screen information associated with the valid display region; pack a plurality of pieces of valid pixel data, the plurality of pieces of valid pixel data corresponding to valid image data to be displayed in the valid display region,